

WE CLAIM:

1. A process for morphing a texture comprising:

determining an incremental morph parameter corresponding to a texel

component, and

in response to said incremental morph parameter, incrementally

interpolating said texel component toward a target texel component state through

at least one intermediate morph texel component state.

2. A process as in claim 1 wherein said incrementally interpolating step

comprises repetitively adding said incremental morph parameter to said texel

component to produce a corresponding sequence of intermediate morph texel

component states.

3. A process as in claim 1 wherein said incrementally interpolating step

comprises using an integer arithmetic calculation to repetitively increment or

decrement said plural texel component based on said determined incremental

morph parameter.

4. A process as in claim 1 wherein said determining step calculates said

incremental morph parameter as the amount of change in said texel component for

each successive time period within a morphing procedure, and said incrementally

interpolating step changes said texel component in response to the integer portion

of said incremental morph parameter.

5. A process as in claim 4 wherein said successive time periods comprise

image frame times.

1 6. A process as in claim 4 wherein said incrementally interpolating step
2 conditions said change in said texel component based on which of said successive
3 time periods has occurred within said morphing procedure to reduce the number of
4 calculations required to morph said textured surface.

1 7. A process as in claim 4 further including selectively adding 1 to or
2 subtracting 1 from said integer portion to reduce approximation errors in the
3 context of integer arithmetic operations.

1 8. A process as in claim 1 wherein said incremental interpolation step
2 comprises incrementing or decrementing said texel component by integer
3 approximations of said determined morph parameter, and compensating for
4 approximation errors by performing at least one floating point operation to set said
5 texel component to a target texel component value.

1 9. A process as in claim 1 wherein said incremental interpolation step
2 selectively interpolates said texel component based on an interlace factor.

1 10. A process as in claim 1 further including conditioning said incremental
2 interpolation step based on an interlace factor.

1 11. A process as in claim 1 further including calculating a frame counter
2 corresponding to said texel component, and selectively incrementing or
3 decrementing said texel component in response to said frame counter.

1 12. A process as in claim 1 further including the preliminary step of storing
2 said texel component in a separate texel component array.

1 13. A process as in claim 12 wherein said texel component comprises one
2 of a red, green or blue color value and an alpha value.

1 14. A system for morphing a textured surface comprising:
2 a determiner that determines an incremental morph parameter
3 corresponding to a texel component, and
4 an incremental interpolator that incrementally interpolates, in response to
5 said incremental morph parameter, said texel component toward a target texel
6 component state through at least one intermediate morph texel component state.

1 15. A system as in claim 14 wherein said incremental interpolator
2 repetitively adds said incremental morph parameter to the texel component to
3 produce a corresponding sequence of intermediate morph texel component states.

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1 16. A system as in claim 14 wherein said incremental interpolator comprises
2 an arithmetic calculator that performs a repetitive integer arithmetic calculation to
3 repetitively increment or decrement said plural texel component based on said
4 determined incremental morph parameter.

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1 17. A system as in claim 14 wherein said incremental interpolator
2 calculates said incremental morph parameter as the amount of change in said texel
3 component for each successive time period within a morphing procedure, and
4 changes said texel component in response to the integer portion of said
5 incremental morph parameter.

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1 18. A system as in claim 17 wherein said successive time periods comprise
2 image frame times.

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19. A system as in claim 17 wherein said incremental interpolator
conditions said change in said texel component based on which of said successive
time periods has occurred within said morphing procedure to as to reduce the
number of calculations required to morph said textured surface.

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19. A system as in claim 17 further including an adder that selectively adds
or subtracts 1 relative to said integer portion to reduce approximation errors in the
context of integer arithmetic operations.

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19. A system as in claim 14 wherein said incremental interpolator
increments or decrements said texel component by integer approximations of said
determined morph parameter, and compensates for approximation errors by
performing at least one floating point operation to set said texel component to a
target texel component value.

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19. A system as in claim 14 wherein said incremental interpolator
selectively interpolates said texel component based on an interlace factor.

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19. A system as in claim 14 further including a conditioner that conditions
said incremental interpolation step based on an interlace factor.

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19. A system as in claim 14 further including a frame counter
corresponding to said texel component, and wherein said incremental interpolator
selectively increments or decrements said texel component in response to said
frame counter.

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19. A system as in claim 14 further including a separate array storing said
texel component arrays.

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2 26. A system as in claim 25 wherein said texel component comprises one of
3 a red, green or blue color value and an alpha value.

1 27. An efficient 3D morphing process for morphing 3D textured objects
2 displayed using a real time interactive 3D graphics system including user-
3 manipulable controls, said system displaying at least one 3D object based at least
4 in part on a texture map comprising plural texels each comprising plural texel
5 components, said 3D morphing process including:

6 (a) calculating incremental morph parameter values for texels of said texture
7 map; and

8 (b) in real time, incrementally changing the value of said plural texel
9 components over time based on said calculated incremental morph parameter
10 values.

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2 28. A process as in claim 27 wherein said calculating step (a) comprises
3 calculating the value of $\Delta r = (TC - SC) / (FR * T)$, where SC is the source texel
4 component value, SC is the target texel component value, FR is the frame rate and
5 T is the morphing duration.

1 29. A process as in claim 28 wherein said incrementally changing step
2 comprises repetitively incrementing or decrementing said plural texel component
3 values by uniform amounts at a first predetermined frequency based on the integer
4 portion of Δr , and adding or subtracting a further integer value at a further
5 predetermined frequency less than said first predetermined frequency.

1 30. A process as in claim 29 wherein said first and second predetermined
2 frequencies are each based on image frame rate.

1 31. A process as in claim 29 wherein said second predetermined frequency
2 is based on a frame counter that counts a predetermined number of image frames.

1 32. An efficient 3D morphing process for morphing 3D textured objects
2 displayed using a real time interactive 3D graphics system including user-
3 manipulable controls, said system displaying at least one 3D object based at least
4 in part on a texture map comprising plural texels each comprising plural texel
5 components, said 3D morphing process including:

6 (a) calculating incremental morph parameter values for said texel
7 components, including rounding down calculated incremental interpolation values
8 to the closest integer values to provide integer results and calculating period
9 counter values based on non-integer remainders of said calculated incremental
10 interpolation values;

11 (b) at least in partial response to user interaction with said controls,
12 changing texel component values at a first periodic frequency based on said
13 integer results; and

14 (c) at least in partial response to said period counter, further changing said
15 texel component values at a second periodic frequency less than said first periodic
16 frequency to compensate for approximation errors introduced by step (b).

1 33. In a real-time interactive graphics system including at least one user-
2 manipulable control, a process for generating animation objects in real time by
3 morphing a source texture map including plural texels each having plural
4 components, into a target texture map including plural texels each having plural
5 components, said process comprising:

6 (a) calculating incremental morph parameter values for texels of said first
7 texture map, and incrementally interpolating the value of said plural texel

8 components of said first texture map over time based on said calculated uniform
9 incremental morph parameter values so as to morph said first texture map toward
10 said second texture map;

11 (b) using an intermediate texture map generated by step (a) to texture map
12 an animation object; and

13 (c) controlling at least one of the displayed orientation and position of said
14 texture-mapped animation object at least in part in response to user manipulation
15 of said control.

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34. A storage device for use with a real-time interactive graphics system
2 including at least one user-manipulable control, said storage device storing
3 information used by said system for generating animation objects in real time by
4 morphing a source texture map including plural texels each having plural
5 components, into a target texture map including plural texels each having plural
6 components, said storage device comprising:

7 a first storage portion that stores information controlling said system to
8 calculate incremental morph parameter values for texels of said first texture map,
9 and to incrementally interpolate the value of said plural texel components of said
10 first texture map over time by uniform integer amounts based on said calculated
11 incremental morph parameter values so as to morph said first texture map through
12 at least one intermediate texture map toward said second texture map;

13 a second storage portion that stores information controlling said system to
14 use said intermediate texture map to texture map an animation object; and

15 a third storage portion that stores information controlling at least one of the
16 displayed orientation and position of said texture-mapped animation object at least
17 in part in response to user manipulation of said control.